Validation of a New High-Speed Fiber-Coupled Four-Wavelength Infrared Pyrometer in the Range of 505 K to 1234 K by a Pulse-Heating Technique, using the Melting Points of Tin, Zinc, Aluminum, and Silver as Reference Points

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We have developed a new high-speed fiber-coupled four-wavelength infrared pyrometer for surface temperature measurements on shocked solids in the absence of a simultaneous dynamic emittance measurement. The instrument is treated as an ensemble of four independent single-wavelength pyrometers, each receiving the radiance emitted by the target in a particular wavelength range. Based on a static reflectance measurement prior to each experiment and/or literature data, reasonable assumptions are made about the lower and upper bounds of the normal spectral emittance of the target in each of these wavelength ranges. For each channel with significant output signal, these emittance bounds, combined with the measured radiance in that channel, yield a lower and upper limit for the target temperature at each instant of time. For temperatures at which significant signal is present in more than one channels, taking the intersection of the corresponding temperature intervals further reduces the range of possible target temperatures, as a function of time. In a first effort to validate the instrument, as well as the method outlined above to deduce temperature from the measured radiances, we have looked at the melting points of tin, zinc, aluminum, and silver, which cover the useful temperature measurement range of this pyrometer. Specimens of each material in the form of strips were resistively heated to their melting points in less than 1 s by the passage of a large current pulse. Temperatures derived from the measured radiances at the melting transition of each metal are compared with published values. In addition, the data was analyzed using traditional multi-wavelength pyrometry methods, i.e. an assumption about the functional form of the wavelength dependence of emittance, and these results are also compared with published melting point values for these materials. We discuss the differences in the two approaches and examine their pros and cons.